DOCUMENT RESUME

ED 359 049 SE 053 470

AUTHOR Mayer, Victor J.
TITLE Earth Systems Education. ERIC/CSMEE Digest.
INSTITUTION ERIC Clearinghouse for Science, Mathematics, and Environmental Education, Columbus, Ohio.
SPONS AGENCY Office of Educational Research and Improvement (ED), Washington, DC.
REPORT NO EDO-SE-93-2
PUB DATE Mar 93
CONTRACT RI88062006
NOTE 3p.
AVAILABLE FROM ERIC Clearinghouse for Science, Mathematics, and Environmental Education, 1929 Kenny Road, Columbus, OH 43210-1080 (first copy, free; $0.25 each additional copy).
PUB TYPE Information Analyses - ERIC Clearinghouse Products (071)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Curriculum Development; *Earth Science; Elementary Secondary Education; Environmental Education; Holistic Approach; Models; *Science Curriculum; *Science Education; *Science Programs
IDENTIFIERS Earth; ERIC Digests; *Program for Leadership in Earth Systems Education

ABSTRACT

National concerns about the quality and effectiveness of science teaching have resulted in several efforts directed at restructuring the United States' science curriculum. This digest discusses recent initiatives of the Earth Systems Education. Topics discussed include: (1) efforts to understand the planet Earth; (2) the Program for Leadership in Earth Science Education (PLESE), a program designed to infuse more content regarding the modern understanding of planet Earth into the K-12 science curricula; (3) the Earth Systems Education framework; (4) Earth Systems education and science curriculum restructuring; and (5) Earth systems education projects. Earth Systems Education offers an effective curriculum development strategy that infuses planet Earth concepts into all levels of the K-12 science curriculum, and provides an organizing theme of an integrated science curriculum that could effectively serve the objective of scientific literacy and recruitment of talent into science and technology careers. Contains 16 references. (MDH)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ERIC CSMEE Digest

Clearinghouse for Science, Mathematics, and Environmental Education EDO-SE-93-2 March 1993

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☒ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

Earth Systems Education

Victor J. Mayer

ED359049

National concerns about the quality and effectiveness of science teaching have resulted in several major efforts directed at restructuring the nation's curriculum, including Project 2061 of the American Association for the Advancement of Science (AAAS, 1989) and the Scope, Sequence, and Coordination project of the National Science Teachers Association (NSTA, 1992). A third effort is the Earth Systems Education program centered at The Ohio State University and the University of Northern Colorado (Mayer, editor, 1992). Its philosophy and approach to science content is consistent with the better-known projects but differs in significant respects, especially in its focus on planet Earth.

Understanding Planet Earth

Over the past two decades there have been tremendous advances in the understanding of planet Earth in part through the use of satellites in data gathering and super computers for data processing. As a result, Earth scientists are reinterpreting the relationships among the various science sub-disciplines and their mode of inquiry. These changes are documented in the "Bretherton Report," developed by a committee of scientists representing various government agencies with Earth science research mandates (Earth Systems Science Committee, 1986). These advances also prompted the organization of a conference of geoscientists and educators in April, 1988, to consider their implications for science curriculum renewal. The 40 scientists and educators, including many scientists from the agencies responsible for the Bretherton Report, developed a preliminary framework of four goals and ten concepts about planet Earth that they felt every citizen should understand (Mayer and Armstrong, 1991). Through subsequent discussions with teachers and Earth science educators at regional and national meetings of the NSTA, a renewed concern emerged for a more adequate treatment of planet Earth in the nation's science curriculum.

Infusion through Teacher Enhancement

In Spring of 1990, the Teacher Enhancement Program of the National Science Foundation awarded a grant to The Ohio State University for the preparation of leadership teams in Earth Systems Education—PLESE, the Program for Leadership in Earth Systems Education. The program was designed to infuse more content regarding the modern understanding of planet Earth into the nation's K–12 science curricula.

In preparation for PLESE, a planning committee composed of ten teachers, curriculum specialists, and geoscientists met in Columbus, Ohio in May, 1990, to develop a conceptual framework to guide the program. Preliminary work included the analysis of the Project 2061 report for content related to Earth systems. The committee used this analysis combined with the results of the 1988 conference to develop a framework consisting of seven understandings. This Framework for Earth Systems Education provided a basis for the PLESE teams to construct resource guides and to select teaching materials for use in infusing Earth systems concepts into the science curriculum in their areas (Mayer, 1991). The program has worked with over 180 teachers in three member teams including an upper elementary teacher, a middle school teacher, and a high school teacher during three-week long summer programs. These teams have conducted Earth Systems awareness workshops in their states, communities, and at national NSTA conferences. During the summer of 1993, selected participants prepared resource guides for use at each of the three grade levels.

Earth Systems Education Framework

The PLESE Planning Committee intentionally arranged the understandings of the Earth Systems Education Framework into a sequence (Mayer, 1991). The first emphasizes the aesthetic values of planet Earth as interpreted in art, music, and literature. By focusing on students' feelings towards the Earth systems, the way in which they and others experience and interpret them, students are drawn into a systematic study of their planet. An aesthetic appreciation of the planet leads the student naturally into a concern for the proper stewardship of its resources: the second understanding of the framework (Mayer, 1990). A developing concern for conserving the economic and aesthetic resources of our planet leads naturally into a desire to understand how the various subsystems function and how we study those subsystems: the substance of the next four understandings. In learning how the subsystems function, students must master basic physics, chemistry, and biology concepts. The last understanding deals with careers and vocations in science, bringing the focus once again back to the immediate concerns and interests of the student (Fortner, editor, 1991).

Earth Systems Education and Science Curriculum Restructuring

Teachers using the Framework to develop their resource guides saw its application for the development of integrated science curricula, an objective of both Project 2061 and NSTA's SS&C effort. What could be more natural than developing K–12 science curricula using the subject of all science investigations—planet Earth—as the unifying theme? Any physical, chemical, or biological process that citizens must understand to be scientifically literate can be taught in the context of its Earth subsystem. That is the thought that has guided a number of teachers and curriculum specialists in considering the implications of Earth Systems Education for the nation's science curriculum reform efforts (Mayer, et al, 1992).

The Earth Systems Education effort also seeks to implement a more holistic philosophy of the nature of science into what has been criticized as a reductionist curriculum. Stephen Gould, occupant of the Agassi Chair of Paleontology at Harvard University has characterized the nature of science as it is

SE053490

presented in today's schools in the United States:

> Most children first meet science in their formal education by learning about a powerful mode of reasoning called "*the* scientific method." Beyond a few platitudes about objectivity and willingness to change one's mind, students learn a restricted stereotype about observation, simplification to tease apart controlling variables, crucial experiment, and prediction with repetition as a test. These classic "billiard ball" modes of simple physical systems grant no uniqueness to time and object—indeed, they remove any special character as a confusing variable—lest repeatability under common conditions be compromised. Thus, when students later confront history, where complex events occur but once in detailed glory, they can only conclude that such a subject must be less than science. And when they approach taxonomic diversity, or phylogentic history, or biogeography—where experiment and repetition have limited application to systems in total—they can only conclude that something beneath science, something merely "descriptive," lies before them (Gould, 1986).

The commonly held image of science that is reinforced in our classrooms is that of controlled laboratory experiments conducted by a balding man wearing a white lab coat. Basic to the Earth Systems Education approach is to give a more comprehensive understanding of the nature of science and its intellectual processes including the historical descriptive approaches commonly used by the earth and biological sciences (Mayer, et al, 1992).

Earth Systems Education efforts also take a constructivist approach to learning both in workshops conducted by the staff and in the curriculum restructuring efforts. Most learning goes on in small collaborative groups working on real issues and problems dealing with the Earth System. Another basic tenant is that curriculum restructuring must be a "grass-roots" effort. Teachers are the curriculum developers. Other individuals, be they university professors, professional association staff, state or local level administrators, serve a facilitating function. The curriculum itself must be developed and therefore owned by the teachers who teach it (Mayer, et al, 1992).

Earth Systems Education Projects

Several projects are underway to test aspects of Earth Systems Education. The oldest and furthest along is the implementation of an integrated Biological and Earth Systems (BESS) science sequence into the high schools in the Worthington (OH) School District (Fortner, et al, 1992). It is a required sequence replacing both Earth science at the 9th grade and Biology at 10th. The sequence is organized around basic Earth systems issues such as resource supply, global climate change, and deforestation. The program incorporates collaborative learning and problem-solving techniques as major instructional strategies. Current technology is also used including on-line and CD-ROM databases for accessing current scientific data for use in course laboratory instruction. Ten additional Ohio and New York school systems are now studying the BESS program for its implications for their curriculum restructuring efforts.

Other efforts at elementary, middle, and high school levels are now underway in school districts in New York, Colorado, Ohio, Oregon, and Illinois.

Conclusion

The time appears to be ripe for the first total restructuring of the science curriculum since the current high school course sequence was established in the late 1800s. The dramatic changes that have taken place in science, in the understanding of how science is learned, in the evolving demands of technology, and in the pressures they place on our environment require this restructuring. Earth Systems Education offers an effective strategy. As a first step, it infuses planet Earth concepts into all levels of the K–12 science curriculum. In the long run, it provides an organizing theme for a K–12 integrated science curriculum that could effectively serve the objectives of scientific literacy and at the same time provides a basis for the recruitment of talent into science and technology careers.

References

American Association for the Advancement of Science. (1989). *Science for all Americans.* Washington, DC: Author.

Earth System Science Committee. (1988). *Earth system science.* Washington, DC: National Aeronautics and Space Administration.

Fortner, R. W., (Ed.). (1991). Earth systems education [Special issue]. *Science Activities, 28*(1).

Fortner, R. W. (1992). Down to earth biology: A planetary perspective for biology curriculum. *The American Biology Teacher, 54*(2), 76-79.

Fortner, R. W., et al. (1992). Biology and earth systems science. *The Science Teacher, 59*(9), 32-37.

Gleick, J. (1987). *Chaos: Making a new science.* NY: Penguin Books.

Gould, S. J. (1986). Evolution and the triumph of homology, or why history matters. *American Scientist, 74,* 60-69.

Mayer, V. J. (1988). *Earth systems education: A new perspective on planet Earth and the science curriculum.* Columbus, OH: The Ohio State University.

Mayer, V. J. (1989). Earth appreciation. *The Science Teacher, 56*(3), 22-25.

Mayer, V. J. (1990). Teaching from a global point of view. *The Science Teacher, 57*(1), 26-30.

Mayer, V. J. (1991). Earth-system science: A planetary perspective. *The Science Teacher, 58*(1), 31-36.

Mayer, V. J. (1991). Framework for Earth systems education. *Science Activities, 28*(1), 8-9.

Mayer, V. J. (Ed.). (1992). *Earth systems education: Origins and opportunities.* Columbus, OH: The Ohio State University.

Mayer, V. J., & Armstrong, R. E. (1990). What every 17-year old should know about planet Earth: The report of a conference of educators and geoscientists. *Science Education, 74*(2) 155-165.

Mayer, V. J., et al. (1992). The role of planet Earth in the new science curriculum. *Journal of Geological Education, 40*(1), 66-73.

The National Science Teachers Association. (1992). *Scope, sequence, and coordination of secondary school science: The content core.* Washington, DC: Author.

OERI This digest was funded by the Office of Educational Research and Improvement, U.S. Department of Education under contract no. RI-88062006. Opinions expressed in this digest do not necessarily reflect the positions or policies of OERI or the Department of Education.

ERIC Educational Resources Information Center. The nationwide information system initiated in 1966 by the U.S. Department of Education. ERIC is the largest and most frequently used education-related database in the world.

SE 053 470

➤ This digest is in the public domain and may be freely reproduced.◄